

What is claimed is:

1. A poison resistant combustible gas sensing element comprising:

an electric heating element;

5 a first layer coated on the electric heating element and comprising a precious metal catalyst supported on a porous oxide, the precious metal catalyst catalyzing combustion of a combustible gas to be detected by the element; and

10 a second layer overlaying the first layer, and comprising a catalytic compound capable of trapping gases and vapors which poison the precious metal catalyst, said catalytic compound being supported on a porous oxide.

15 2. The sensing element of claim 1, wherein the catalytic compound is at least one compound selected from the group consisting of:

a) metal oxides selected from the group consisting of oxides of vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), molybdenum (Mo), tin (Sn), antimony (As), lead (Pb), bismuth (Bi), ruthenium (Ru), cadmium (Cd), rhenium (Re), osmium (Os), and iridium (Ir);

b) solid acids selected from the group consisting of tungsten oxide/zirconia, sulfated zirconia, niobium oxide, silica-alumina, mesoporous aluminosilicates, mesoporous sulfated zirconia and acid-activated clays;

c) solid bases selected from the group consisting of magnesia, alkaline-doped alumina and alkaline-doped zeolites; and

d) metal-loaded zeolites and clays.

5       3. The sensing element of claim 2, wherein the metal oxide is supported on a porous oxide selected from the group consisting of alumina, zirconia, silica, yttrium-stabilized zirconia, cerium-stabilized zirconia and lanthanum-stabilized zirconia.

10      4. The sensing element of claim 1, wherein the heating element comprises a helical filament heater.

5       5. The sensing element of claim 1, wherein the heating element comprises an electric film heater.

15      6. The sensing element of claim 1, wherein the catalytic compound of the second layer is in solid form.

7. The sensing element of claim 1, wherein the catalytic compound of the second layer is in powder form.

8. The sensing element of claim 1, wherein the second layer comprises multiple layers of catalytic compounds.

20      9. The sensing element of claim 1, wherein the second layer comprises an external filter.

10. The sensing element of claim 9, wherein the external filter comprises a catalytic compound supported on paper, or in the form of a blank or monolith.

11. The sensing element of claim 1, wherein the second

layer comprises at least one layer comprising a precious metal catalyst supported on a porous oxide, and at least one layer comprising a said catalytic compound supported on a porous oxide.

5           12. An apparatus for detecting a combustible gas comprising:

10           a gas sensing element including an electric heating element, a first layer coated on the electric heating element and comprising a precious metal catalyst supported on a porous oxide, the precious metal catalyst catalyzing combustion of a combustible gas to be detected by the sensing element, and a second layer overlaying the first layer, and comprising a catalytic compound capable of trapping gases which poison the precious metal catalyst, said catalytic compound being supported on a porous oxide; and

15           a compensating element comprising an electric heating element, said compensating element not including a catalyst capable of catalyzing combustion of a combustible gas to be detected by the sensing element.

20           13. The apparatus of claim 12, further comprising an electrical circuit to which the sensing element and compensating element are connected, said electrical circuit being constructed and arranged to detect changes in resistance of the sensing element and compensating element.

25           14. The apparatus of claim 13, wherein the electrical

circuit comprises a Wheatstone bridge including a voltmeter.

15. A process for forming a gas sensing element comprising the steps of:

coating onto an electric heating element an inner layer comprising a mixture of at least one porous oxide support material with a precious metal oxide catalyst precursor;

heating the electric heating element to form the precious metal oxide catalyst dispersed on the porous oxide support; completely covering the heated inner layer with an outer layer comprising a slurry containing at least one porous oxide support material and a catalytic compound capable to trapping gases which poison the precious metal catalyst; and

heating said slurry to form a catalytic compound supported on a porous oxide in the outer layer.

16. The method of claim 15, wherein the catalytic compound is at least one compound selected from the group consisting of:

a) metal oxides selected from the group consisting of oxides of vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), molybdenum (Mo), tin (Sn), antimony (As), lead (Pb), bismuth (Bi), ruthenium (Ru), cadmium (Cd), rhenium (Re), osmium (Os), and iridium (Ir);

b) solid acids selected from the group consisting of tungsten oxide/zirconia, sulfated zirconia, niobium oxide,

silica-alumina, mesoporous aluminosilicates, mesoporous sulfated zirconia and acid-activated clays;

5           c) solid bases selected from the group consisting of magnesia, alkaline-doped alumina and alkaline-doped zeolites; and

             d) metal-loaded zeolites and clays.

10          17. The method of claim 16, wherein the metal oxide is supported on a porous oxide selected from the group consisting of alumina, zirconia, silica, yttrium-stabilized zirconia, cerium-stabilized zirconia and lanthanum-stabilized zirconia.

15          18. The method of claim 15, wherein the precious metal oxide catalyst precursor is selected from the group consisting of palladium chloride, hexachloroplatinic acid, rhodium chloride and mixtures thereof.

19. A method for determining poisoning of a gas sensing element comprising the steps of:

20          a) forming an apparatus for detecting a combustible gas comprising:

             a gas sensing element including an electric heating element, a first layer coated on the electric heating element and comprising a precious metal catalyst supported on a porous oxide, the precious metal catalyst catalyzing combustion of a combustible gas to be detected by the sensing element, and a second layer overlaying the first layer, and comprising a catalytic compound capable to trapping gases which poison the

precious metal catalyst, said catalytic compound being supported on a porous oxide;

5           a compensating element comprising an electric heating element, said compensating element not including a catalyst capable of catalyzing combustion of a combustible gas to be detected by the sensing element; and

10          an electrical circuit to which the sensing element and compensating element are connected, said electrical circuit being constructed and arranged to detect changes in resistance of the sensing element and compensating element, and to provide a reading of said changes;

15          b) operating said apparatus in an atmosphere substantially without combustible gases to determine a baseline reading for said apparatus; and

20          c) continuing to observe said baseline reading, with a drift of baseline indicating poisoning of said gas sensing element.

25          20. The method of claim 19, wherein the drift is a negative drift.